enthusiasm. Elevation perhaps comes nearest to a solution, but fails to account for world-wide cooling. The conclusion is that no single cause suffices. "Some combination of astronomic, geologic, and atmospheric conditions seems to be necessary to produce such catastrophic events in the world's history."

The difficulty of the problem is increased by the apparently haphazard way in which glaciations have developed. Time and again the author comments on the paradox of field work, especially on Permo-Carboniferous tillites, beneath an almost vertical sun in a temperature suggestive of anything but ice. On the other hand, so far as is known at present, the Antarctic continent escaped glaciation until the close of the Mesozoic, though of course the great Antarctic ice sheet may hide traces of many older glaciers. The northeast of North America, where the Quaternary ice sheets reached lower latitudes than anywhere else, has suffered glaciation over and over again. In the upper Carboniferous this region bore glaciers which indeed pale into insignificance beside the contemporaneous ice sheets of the south, but would be sufficiently remarkable in any other period. The same region was ice-covered in the Devonian, the Ordovician, at the close of the Proterozoic, in the lower Huronian (a photograph shows the remarkable feature of a Huronian tillite smoothed and striated by a Pleistocene ice sheet), and perhaps at two horizons in the Archæan—seven or eight glaciations in the same or neighboring areas. Other regions which have suffered repeated glaciation are Alaska, South Africa, and southeast Australia, though South Africa was not glaciated during the Pleistocene.

It almost seems as if, given certain conditions, and especially a world-wide cooling, glaciers and even ice sheets can develop in any latitude, but have a preference for certain localities. From this point of view it may be only an accident that the two great ice sheets of the present day occur in high latitudes. Their formation is not entirely a matter of temperature, since we are faced by the idea that during most of geological time the polar regions were free of land ice even while lower latitudes were being glaciated. Apart from pole wandering, the only theory which throws any light on this anomaly is Paschinger's, not mentioned by Coleman, that glaciation depends on the relation between the zone of maximum snowfall and the snow line. It may be profitable to try to fit this theory to the facts before us.

As we go from the lowlands up the slopes of a mountain range, we find that the snowfall increases up to a certain level, above which it again decreases; this level depends mainly on the humidity and the temperature during the wettest season. Quite distinct, depending mainly on the summer temperature, is the snow line. If the snow line is above the zone of maximum snowfall, the glaciers will be small; if the snow line is the lower, the glaciers will be large, and with sufficient snowfall may descend to low levels. In the moist equatorial regions the two zones are close together, and a small depression of the snow line would produce a considerable extension of the glaciers.

It seems probable that glaciers or ice sheets must always *originate* on high ground, but for a glacier to develop into an ice sheet a large area of more or less level ground is required at a temperature low enough for the ice to spread out as a piedmont glacier. In high latitudes this land may be low, but in low latitudes it must be initially at a high level. Once the ice sheet has reached a certain size, however, it imports its own climate, and the initially high plateau may be depressed nearly to sea level without necessarily destroying the ice sheet. There are several reasons for this. One of the most important is that a snow surface reflects four-fifths of the solar radiation falling on it, and another is that a large ice sheet is naturally occupied by an anticyclone with outwardly directed winds. The relations between snow line and zone of maximum snowfall probably depend on conditions of storminess and vertical temperature gradient which are due to general causes; when these are favorable, glaciers will form which may develop into ice sheets in suitable localities, determined partly by configuration, which is independent of latitude, and partly by location relative to storm tracks and oceans. The latter proviso causes the repetition of glaciation in certain localities which are not necessarily the coldest parts of the globe. During the course of an ice age the most suitable location may change, which brings us back to Coleman's speculation that the Greenland ice sheet may represent the continuation of the eastward trend of glaciation in America, having commenced later than the American ice sheets and persisting after them.

The author has done good service by uniting in one volume a large mass of material which was formerly only available in scattered papers or, in the case of his own observations, had not previously been published. The volume maintains the high standard which we expect of the publishers; it is lavishly illustrated by photographs of great interest, and the only error which the reviewer has noticed is the name "Grygalski" on page 286.—*C. E. P. Brooks.*

THE CLIMATE OF NORTH-EAST LAND

In a paper in the *Geographical Journal* for September on the weather of North-East Land, Spitsbergen, during one month in the summer of 1924, Mr. K. S. Sandford has collected some evidence of value in relation to the problem of glacial anticyclones. In this relatively small but almost entirely ice-covered area he found no fixed anticyclone but a definite tendency toward the establishment of anticyclonic conditions with radial gravitational winds. This intermittent glacial anticyclone is blotted out by interference from outside the area but quickly reestablishes itself. Winds are markedly outflowing and lead to an augmentation of the bordering ice at the expense of the higher parts of the interior. On the other hand, interference from the outside is great and leads to melting of ice in the bordering zone and to a less extent in the interior. During the maintenance of anticyclonic conditions there is some indication of a pulsation, from calm to blizzard. Mr. Sandford believes that on New Friesland, on the mainland of Spitsbergen, there is a similar but modified system. Other parts of Spitsbergen have an insufficient ice covering for its development. Up to the present there are no winter observations available from North-East Land.—*Repr. from Nature (London), September 6, 1926.*

EXTENT OF ORCHARD HEATING IN SOUTHERN CALIFORNIA

The fruit-frost service of the Weather Bureau, in charge of Mr. Floyd D. Young, is compiling data on this subject, which when completed will form the first authoritative information with regard to it. The work is divided into eight districts, for each of which it is hoped to have complete data before the spring of 1927. In summarizing the work for the Redlands-San Bernardino district, Mr. A. W. Cook, of the Weather Bureau, writes as follows (*California Citrograph*, July, 1926):

> There are 29,691 acres of citrus trees in the entire Redlands-San Bernardino fruit-frost district, of which 5,789 acres, or 19.5 per cent, are equipped with heaters. The increase in acreage protected since the spring of 1925 is 2,977, or 51.4 per cent of the total. On the basis of fifty 9-gallon oil heaters to the acre, 2,483,550 gallons, or roughly 250 carloads, of oil are required for one filling of the heaters. The Redlands section alone requires about 187 carloads of oil for one filling.

551.508 A ONE-MAN THEODOLITE

The August, 1926, issue of *Meteorologische Zeitschrift* contains a description, with illustration, of this device, which appears to be new in the field of aerology. The advantages of a one-man instrument for use on meteorological expeditions or other situation where reduction of personnel is essential are obvious.

In the new instrument the horizontal circle is retained in the form hitherto used, but the vertical circle is ingeniously incorporated within the field of vision of the telescope. The operator with his right eye not only follows the balloon with the aid of the cross hairs, but, aided by their lower vertical member as an index, he with the same eye reads the vertical angle upon an engraved glass circle. Set off at interpupillary distance to the left of the main eyepiece is the ocular of a microscope through which the observer looks, via a prism, upon the scale engraved on the horizontal circle.

Both horizontal and vertical circles are divided into whole degrees. Reading to tenths of a degree is accom-

plished by fitting the horizontal circle with a six-minute vernier, and, in the case of the vertical circle, by depending upon the magnification, aided by the lower cross-hair member, for estimating the tenths.

One may infer that a certain agility will be required of the operator in using two eyes at different tasks almost simultaneously. This should be by no means an insuperable obstacle to the usefulness of the new one-man theodolite.

In the instrument described, the diameter of the objective is 36 millimeters, magnification 10 times, and field of view 5.5°.—*B. M. V.*

ESTABLISHMENT OF METEOROLOGICAL STATIONS IN MONGOLIA

(Translated from Petermann's Mitteilungen, 1926, Heft 1/2)

* * * Dr. W. B. Schostakowitsch, director of the Meteorological and Magnetic Observatory at Irkutsk, has been establishing during the last two years a meteorological observing service in Mongolia under commission from the Mongolian Government.

In addition to the meteorological observatory at Urga (in Mongolian: Ulan Bator Choto) (47° 55′ N., 106° 50′ E.) there are at present seven stations:

Uljassutai (47° 44′ N., 96° 52′ E.).
Wangin (49° 28′ N., 98° 51′ E.).
Chatyl (50° 30′ N., 100° 32′ E.) at the south end of the Kossogol.
Dsain Schabi (47° 46′ N., 101° 03′ E.).
Sangin (47° 52′ N., 106° 48′ E.).
Ude (44° 35′ N., 111° 10′ E.).
San Reisse (48° 00′ N., 112° 42′ E.).

All the stations were established with the support of the Central Geophysical Observatory at Leningrad.

The stations at Urga and Ude were already in existence, and for the period 1894–1903 had furnished valuable observations. From Uljassutai there are only the few observations of H. Fritsche for 1879–80. All the other stations are quite new and of the greatest importance for our future enlightenment as to the climate of northern Mongolia, now known only in bare outline. With the exception of Ude and San Reisse, all the stations lie in the Changai Mountains region, and it is very much to be desired that the town of Kobdo, from which we have complete observations only for 1896 and for scattered months in 1895 and 1897, should be included in the net of stations.

At the Urga Observatory, modern registering apparatus such as barographs, thermographs, hygrographs, and heliographs are in use, and a Michelsson actinometer. Beginning with October of this year, study of the upper air currents with pilot balloons was begun.

Through the observations of this new, albeit wide-meshed net, we have now a good basis for following into Mongolia the cold and warm waves in thin surface layers of air, which, originating over the northern ice-covered sea and spreading thence eastward and westward, H. von Ficker has traced as far as the western edge of the Russian Altai Mountains, even to Barnaul. From von Ficker we have the newest and most comprehensive description of the climate of central Asia. (Geogr. Ann., 1923, pp. 351–400.)

In the course of the next year the work of the stations will be extended to include magnetic and seismic observations. * * * —*Paul Fickeler, Munich.*

METEOROLOGICAL SUMMARY FOR SOUTHERN SOUTH AMERICA, AUGUST, 1926

By J. BUSTOS NAVARRETE, Director

[Observatorio del Salto, Santiago, Chile]

The month of August was relatively dry, the atmospheric régime in the central zone being characterized by stability and continuity. During the first seven days the régime was a high-pressure one, with cloudy weather and cold in the central zone, and some drizzle and scattered rains in the south.

Between the 8th and the 11th an important depression influenced the country, causing general bad weather. On the 11th it rained from Coquimbo to Chiloe, the maximum precipitation being registered at Punta Tumbes, 100 millimeters.

Between the 12th and the 17th the high-pressure régime was reestablished, causing the fine weather to continue. On the 18th and 19th a rather important depression affected the central zone, causing cloudiness, fog, and drizzle. Then followed another period of good weather from the 20th to the 24th. On the 25th and 26th a large depression crossed the far southern region, causing bad weather and rains in the southern zone. Precipitation exceeded 30 millimeters. Between the 28th and 30th another depression crossed the far south. Rain fell from Aconcagua to Chiloe; 24-hour rainfall up to 50 millimeters was registered. In the southern zone this storm was a violent one.—*Transl. B. M. V.*

METEOROLOGICAL SUMMARY FOR BRAZIL, AUGUST, 1926

By FRANCISCO SOUZA, Acting Director

[Directoria de Meteorologia, Rio de Janeiro]

The secondary circulation during August was less active than in July; the anticyclones moved along less meridional paths but were still very extensive. Four HIGHS invaded southern Brazil, while the continental depression and those of high latitudes were especially active, principally on the 10th, 11th, and 21st, there forming on this latter date over the Argentine littoral in the latitude of Mar del Plata a secondary that produced very strong winds which reached the southern part of Brazil.

Rains in the north were generally scant, averaging 30 millimeters below normal. In the central and southern regions irregular precipitation was observed, which departed little from the normals.

The harvesting of cotton was practically finished; yields in the north did not meet expectations. The coffee harvest is about ended and has produced a normal yield. The yields of cane have been good, and rains in the north favored tillage and the new planting, as they did also in the central region. Tobacco has yielded well, and the new planting is in process.

The weather at Rio was in general good, with little cloud except from the 17th to the 19th and the 23d to the 27th, which were unsettled. The month was mildly warm, though the nights were a little cooler than normal for August. The mean temperature and the mean maximum were slightly above their normals, the mean minimum slightly below. Rains were abundant in the third decade, being 58 millimeters above the normal. Winds were prevailing southerly and of moderate velocity, except that there occurred in the early morning of the 24th a squall from south-southwest which attained a maximum velocity of 19.9 m. p. s. at 12.45 a. m.—*Translation, W. W. R. and B. M. V.*